Proposed
Total Maximum Daily Load Development
For the Middle and Lower
St. Johns River, Florida

Nutrients, DO, BOD, Fecal Coliforms,
Iron, Lead, Silver, Selenium

September 30, 2003

Region4 serving the southeast

TABLE OF CONTENTS

List of Tables

List of Figures

LIST OF ABBREVIATIONS

BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
FDEP	Florida Department of Environmental Protection
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
SJRWMD	St. Johns River Water Management District
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET

Total Maximum Daily Load (TMDL) Development for the

Lower St. Johns River Basin

? **303(d) Listed Waterbody Information**

State	Florida
County	Flagler, St. Johns, Putnam, Volusia, Orange
Major River Basin	Lower St. Johns River Basin
Watershed	3080101, 3080103, 3080201
Constituent(s) Causing Impairments	Nutrients (TN, TP), Dissolved Oxygen, BOD, Fecal Coliforms, Iron, Lead, Silver, Selenium
Designated Uses	Class III

TMDL Development

? **Analysis/Modeling**:

St Johns River Water Management District's Pollutant Load Screening Model (PLSM) was used to develop estimates of current nutrient and BOD loading from nonpoint sources in several WBIDs in the Middle and Lower St. Johns River Basins. Information from WAFR was used to develop estimates for point source loading from permitted wastewater treatment plants. Nutrient load reduction targets that will be protective of the St. Johns River Class III designated use of Recreation, Propagation and Maintenance of a Healthy, Well-balanced Population of Fish and Wildlife were derived from the draft TMDL for the Lower St. Johns River (FDEP, 2003).

The Fecal Coliform TMDL for Mill Branch was developed using the EPA recommended loading curve approach, fecal coliform data, and stream flows from nearby Deep Creek.

Critical Conditions/Seasonal Variation:

This report expresses nutrient loads as annual averages. The SJRWMD PLSM model employed in this analysis accounts for seasonal variations by adjusting runoff coefficients and event mean concentrations by season. By adjusting the runoff coefficients and event mean concentrations used in the model, PLSM is able to account for seasonal variations within the study area.

The fecal coliform TMDL expresses coliform counts as an average count per day. The average allowable count considers a range of flow conditions excluding extreme dry and wet weather events.

Nutrient and BOD Load Allocations by WBIID

WBID	WLAs (lb per year)			LAs (lb per year)			MOS (lb per year)	TMDL (lb per year)		
Parameter	TN	TP	BOD	TN	TP	BOD		TN	TP	BOD
2540				116671	26715	59496	implicit	116671	26715	59496
2549			16110	118080	27149	58229	implicit	118080	27149	74339
2555	1631	185	2285	43759	10958	19351	implicit	45390	11143	21636
2569				31524	6417	21891	implicit	31524	6417	21891
2592				41208	9999	20664	implicit	41208	9999	20664
2622A				21350	4438	23257	implicit	21350	4438	23257
3030				11028	2008	14298	implicit	11028	2008	14298
Tributary WBIDs				213043	52783	77047	implicit	213043	52783	77047
Total	1631	185	18395	596663	140467	294233	implicit	598294	140652	312628

Fecal Coliform Load Allocation for Mill Branch

Wasteload Allocation	Load Allocation	Margin of Safety	TMDL
0	9.9578E+10 counts per day	implicit	9.9578E+10 counts per day

Average Percent Reductions for Metals TMDLs

WBID	Parameter	Observations	Violations	Florida Criteria	Average Percent Reduction
2213K	Silver	145	42	0.07	55.1
2213L	Silver	208	69	0.07	60.0
2540	Iron	6	4	1.0	37.3
2540	Silver	48	13	0.07	50.7
2549	Silver	78	24	0.07	62.1
2549	Iron	111	17	1.0	57
2569	Iron	5	4	1.0	48.8
2569	Silver	25	6	0.07	86.5
2622A	Selenium	49	9	5	70.7
2622A	Silver	9	2	0.07	56.2
2622A	Iron	57	22	1.0	32.9
2622A	Lead	51	33	$e^{(1.273[\ln H]-4.705)}$	61.8

? Public Notice Date: September 30, 2003

? Endangered Species (yes or blank):

? EPA Lead on TMDL (EPA or blank): EPA

? TMDL Considers Point Source, Nonpoint Source, or Both: Both

? NPDES Discharges of Nutrients and BOD

Waste load allocations (WLAs) for NPDES permitted facilities in Middle/Lower St. Johns watershed

WBID	NPDES No.	Facility Name	TN WLA (lbs)	TP WLA (lbs)	BOD WLA (lbs)
2555	FL0042315	HASTINGS WWTF	1417	185	2285
2555	FL0169226	HASTINGS WTP - RO REJECT	214	---	---
2549	FL0278076	ANGUILLA FISH FARM	---	---	16110
2592	FLA117447	PUTNAM CORRECTIONAL WWTF (FDOC)	---	---	---
2622A	FLA189782	COWART RANCH RESIDUALS MANAGEMENT FACILITY	---	---	---

1. Introduction

The Clean Water Act (CWA) [40 CFR Part 130] requires each State to identify waters within its boundaries not meeting water quality standards applicable to the water's designated uses. This list of identified waters (referred to as the 303(d) list) must be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. The "listed" waters identified by the State are prioritized for Total Maximum Daily Loads (TMDL) development based on factors described in CWA regulations, such as the use of the water and the severity of pollution. A separate TMDL is established for each pollutant at a level necessary to attain the applicable water quality standards taking into account seasonal variations and a margin of safety. The TMDL establishes allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. With this information, states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. Portions of the Lower and Middle St. Johns River watersheds addressed in this report are scheduled for TMDL development by September 30, 2003 in a 1999 Consent Decree (FL Wildlife Federation et. al. v. Carol Browner et. al., Case No. 98-35b-CIV-Stafford). These areas are geographically located within the boundaries of the St. Johns River Water Management District (SJRWMD).

In addition, EPA is proposing the TMDLs located in Appendix A for the mainstem of the middle and lower St. Johns River. These TMDLs have been developed by FDEP with the assistance of the St. Johns River Water Management District. EPA is proposing them federally in order to meet the consent decree requirements. EPA will be accepting comments on these TMDLs in the same manner as those written by EPA in the main body of this report. EPA requests particular attention and comment on the chlorophyll a target used to develop the allocations for the fresh water portions of the St. Johns River as this drives many of the calculations and represents a direct interpretation of FDEP's narrative nutrient criteria at 62-302.530(48)(b).

2. Problem Definition

There are 9 segments of the St. Johns River Basin (Figure 1 & Table 1) that were identified on the Florida Department of Environmental Protection (FDEP) 1998 303(d) list as impaired for various parameters. These are scheduled for TMDL development by September 30, 2003. This schedule is mandated by a 1999 Consent Decree (Florida Wildlife Federation et. al. v. Carol Browner et. al., Case No. 98-356-CIV-Stafford). The pollutants for which TMDLs will be established are nutrients, dissolved oxygen, BOD, fecal coliforms, iron, lead, silver and selenium. Reanalysis of these segments in 2003 by FDEP indicated that these parameters may no longer be parameters of concern, and they may not require TMDLs. To meet the requirements of the 1999 Consent Decree though, EPA has taken the lead on establishing the TMDLs for the pollutants of concern for these segments.

Table 1 Impaired WBIDs within the St. Johns River Basin

WBID Name	WBID	Basin	Body	Parameters for TMDL
STJ RIV AB TOCIO	2213K	Lower St. Johns	LAKE	Silver
STJ RIV AB FEDERAL PT	2213L	Lower St. Johns	LAKE	Silver
MOCCASIN BRANCH	2540	Lower St. Johns	STREAM	DO, BOD, Iron, Silver
DEEP CREEK	2549	Lower St. Johns	STREAM	Nutrients, DO, BOD, Silver, Iron
CRACKER BRANCH	2555	Lower St. Johns	STREAM	Nutrients, DO, BOD
WEST RUN INTERCEPTER D	2569	Lower St. Johns	STREAM	Nutrients, BOD, DO, Silver, Iron
MILL BRANCH	2592	Lower St. Johns	STREAM	Nutrients, BOD, DO, Fecal Coliforms
HAW CK AB CRESCENT LK	2622A	Lower St. Johns	STREAM	Nutrients, DO, BOD, Iron, Selenium, Lead Silver
LONG BRANCH	3030	Middle St. Johns	STREAM	DO, BOD, Nutrients

The TMDLs addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). These conditions include a requirement that TMDLs be proposed for the St. Johns River Basin by September 30, 2003, for each water on the 1998 303(d) list that is designated as not meeting water quality standards.

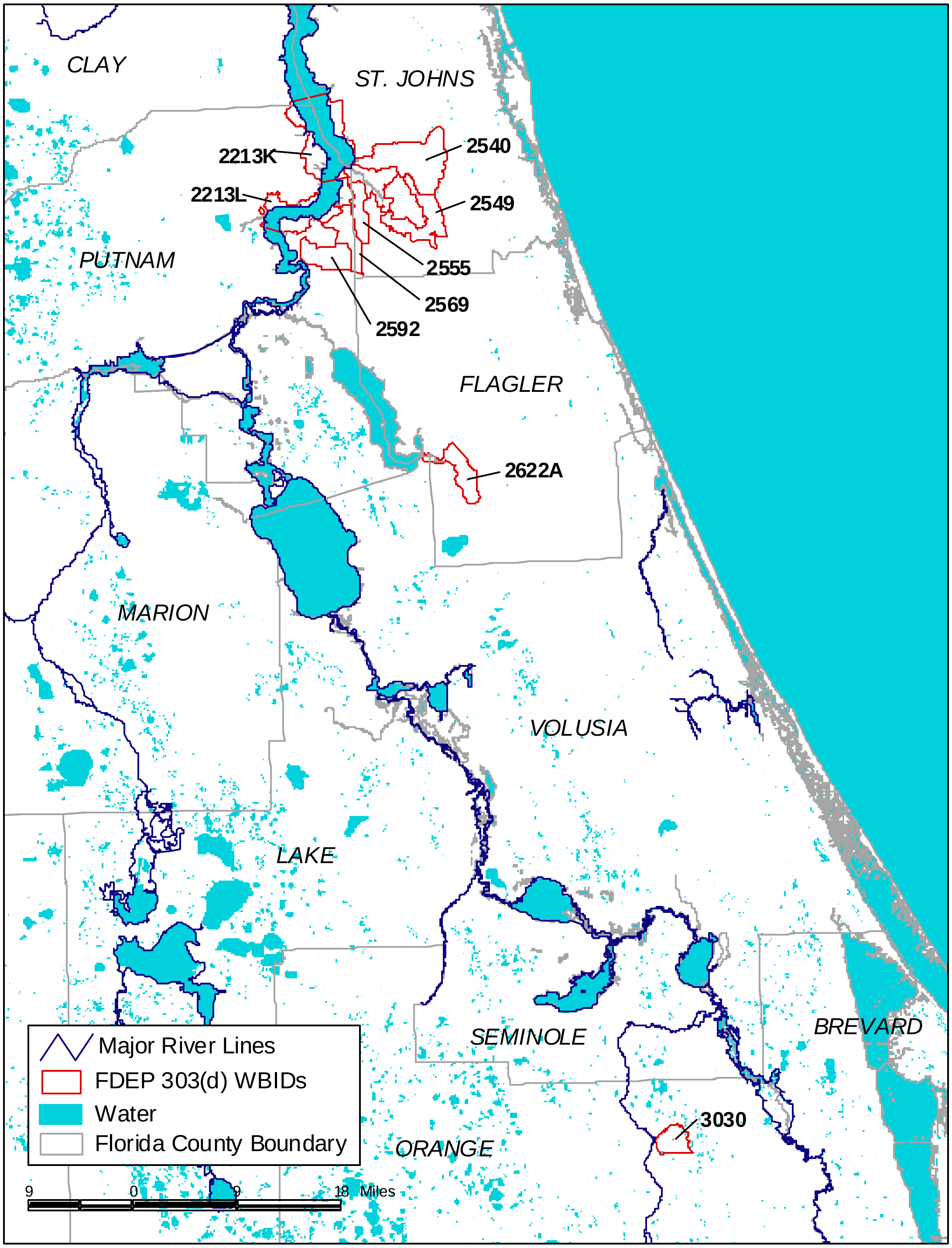

Figure 1 Impaired WBIDs within the St. Johns River Basin

3. Watershed Description

The St. Johns River is a large river system flowing from south to north just inland from the eastern coast of central and northern Florida and drains a watershed covering approximately 9500 square miles before discharging into the Atlantic Ocean east of the City of Jacksonville. The St. Johns River has been divided into three subwatersheds commonly referred to as the Upper, Middle and Lower St. Johns River. 7 of 9 WBIDs presented in this TMDL Report are located within the Lower St. Johns River Basin, while Haw Creek (WBID 2622A) and Long Branch (WBID 3030) lie within the Middle St. Johns River Basin. All of these WBIDS lie within the entirely freshwater portion of the St. Johns River system south of the mesohaline and oligohaline zones. The combined drainage area of the Middle and Lower St. Johns River watershed is approximately 8400 square miles and consists of primarily rural, agricultural and undeveloped lands to the south and more urbanized lands in the north in the vicinity of the greater Jacksonville metropolitan area (Hendrickson and Konwinski, 1998). All of the WBIDs discussed in this TMDL report lie to the south of Jacksonville with mostly agricultural, rural residential, managed forests and undeveloped lands (Figure 3). The tributary streams discussed in this TMDL Report are typically first, second and third order streams characterized by relatively small drainage areas, low gradients, low velocities and are dark waters highly colored by organic materials.

Eutrophication of the St. Johns River has received the attention of the St. Johns River Water Management District and the Florida Department of Environmental Protection and other entities since the 1950's. Point source loading from wastewater treatment plants and nonpoint source loading from urban stormwater have been addressed through the years in an attempt to control eutrophication in the river. At present, FDEP and SJRWMD are developing a nutrient TMDL for the mainstem of the St. Johns River using detailed hydrodynamic modeling of the river and estuary system, and an established land-use based loading model (Pollutant Load Screening Model or "PLSM") to calculate current nutrient load inputs to the river (Hendrickson and Konwinski, 1998, and Magley and Joyner, draft). The Lower St. Johns River mainstem nutrient TMDL proposes to require a 30% load reduction of nonpoint sources of nitrogen and phosphorus, and additional load reductions from many of the permitted point sources. This TMDL Report focuses on several of the tributary WBIDs within the Lower and Middle St. Johns River Basins that contribute to the overall nutrient load of the river but are not addressed specifically in the FDEP TMDL. In addition, this report address parameters such as dissolved oxygen, biochemical oxygen demand, fecal coliform, silver, selenium and iron that caused several of the WBIDs to be listed on the 1998 Consent Decree but were not addressed in the LSJRB TMDL. This TMDL report applies the SJRWMD PLSM model methodology for nutrients and BOD to maintain consistency with the FDEP-SJRWMD approach.

4. Water Quality Standards

The Middle and Lower St. Johns River Basins are Class III Freshwater with designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife (FAC 62-302.400 (1)). The water quality standards in violation that led to the original listing are as follows:

4.1. Narrative Nutrients

"In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." (FAC 62.302.530 (48)(b))

4.2. Dissolved Oxygen

"Shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained." (FAC 62-302.530 (31))

4.3. Biochemical Oxygen Demand

"Shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to cause nuisance conditions." (FAC 62-302.530 (12))

4.4. Bacteriological Quality – Fecal Coliform

"Most Probable Number or MF counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of ten samples taken over a 30 day period." (FAC 62-302.530 (6))

4.5. Silver

"Less than or equal to .07 micrograms per liter." (FAC 62-302.530 (60))

4.6. Selenium

"Less than or equal to 5 micrograms per liter." (FAC 62-302.530 (59))

4.7. Iron

"Less than or equal to 1 milligram per liter." (FAC 62-302.530 (39))

4.8. Lead

"Less than or equal to a value of $e^{(1.273[\ln H]-4.705)}$ micrograms per liter, where 'lnH' means the natural logarithm of total hardness expressed as milligram/L of $CaCO_3$. For metals criteria involving equations with hardness, the hardness shall be set at 25 mg/L if actual hardness is less than 25 and set at 400 mg/L if actual hardness is greater than 400 mg/L." (FAC 62-302.530 (40))

5. Linkage of Water Quality Standards to the Critical Resource

5.1. Narrative Nutrients

Excessive nutrients in a waterbody can have many unfavorable effects on the designated uses of that waterbody. They can affect the drinking water supply, recreational uses, aquatic life uses and fisheries use. Waterbodies are often listed as impaired for nutrients due to their role in accelerating eutrophication in a waterbody. A eutrophic system can easily succumb to excessive plant growth, particularly as phytoplankton, periphyton and macrophytes. The eutrophication process can adversely affect the waterbody by depleting oxygen in the system, infecting water supplies by algal growth and forcing restrictions of recreational uses due to excessive plant growth. In this TMDL, the target for nutrient load reductions is 30% which is tied to an in-river chlorophyll_a target of 40 micrograms per liter not exceeded more than 10% of the time. This target is established and discussed in detail in the draft Lower St. Johns River nutrient TMDL.

5.2. Dissolved Oxygen

Extreme oxygen depletion can stress or eliminate desirable aquatic life and nutrients, and due to lowered dissolved oxygen, toxins may be released from the sediments, further adversely affecting aquatic life. In this TMDL, the assumption is made that low levels of dissolved oxygen are a function of nutrient enrichment and elevated biochemical oxygen demand. By addressing nutrient enrichment and BOD, any remaining depressed DO levels are likely to be the result of natural background conditions typically observed in warm weather, shallow, slow moving streams.

5.3. Biochemical Oxygen Demand

Bacteria feed on organic matter discharged into the water, or from decaying plants and animal wastes. As the organic substances are decomposed by the bacteria, dissolved oxygen in the water is consumed. If large quantities of such matter are discharged into the water the bacteria's biochemical oxygen demand (BOD) can seriously deplete dissolved oxygen levels in the water. High levels of BOD are a particular problem in low flushing areas where water circulates very slowly. In this TMDL, the BOD target is based upon the 30% load reduction targets established in the draft LSJR TMDL. In addition, an effort was made to estimate the historic load of BOD to the system prior to human development by converting terrestrial land uses to upland forest and re-running PLSM. Interestingly, pre-development BOD loads were approximately 30% lower than current levels using PLSM.

5.4. Fecal Coliform

Fecal coliform bacteria in the water column can induce gastrointestinal, respiratory, eye, ear, nose and throat illnesses and skin diseases in humans. In addition, fecal coliform are used as an indicator of the likely presence of pathogens that pose other potential health risks (EPA 2001). For this TMDL the water quality target for fecal coliform is the State of Florida numeric criterion of 800 cfu per 100 milliliters of water. This target is applied across a wide range of flow conditions using a loading curve approach in order to determine the average daily load of fecal coliform cfu that would meet the water quality criteria.

5.5. Silver

Silver that is released into the environment may be carried long distances in air and water. Rain washes silver compounds out of many soils so that it eventually moves into the groundwater. Silver is stable and remains in the environment in one form or another until it is taken out again by people. Because silver is an element, it does not break down, but it can change its form by combining with other substances. The form it is found in depends on environmental conditions. People are exposed daily to very low levels of silver mainly in food and drinking water, and less in air. Silver bioaccumulates at low concentrations because most silver compounds are only sparingly soluble in water. Planktonic concentrations are correlated with water levels and benthos concentrations are correlated with sediment levels. For this TMDL, the water quality target for silver is based upon the numerical criteria provided in FAC 62-302.530, where a percent reduction is calculated for each violation of the criteria, and then an average of all the reductions is determined. The TMDL for silver is given as an overall percent reduction.

5.6. Selenium

Though selenium is an essential nutrient for humans and animals it is quite harmful to humans and animals when eaten in amounts that are much higher than the amounts needed for good nutrition. Selenium is a naturally occurring substance, and is also found to be most commonly produced as a byproduct of copper refining. When selenium enters the environment, particles in the air settle to the ground or are taken out of the air in rain. Selenium compounds deposited in agricultural fields from fertilizer use can be carried in irrigation drainage water. Plants easily take up selenium compounds from water and concentrate them. Selenium can build up in animals that eat plants or other animals with high levels of selenium. It can also build up in animals that live in water containing high levels of selenium. Humans may encounter selenium by eating food, drinking water, with high levels of the element, or being exposed to it in the air. When animals absorb or accumulate extremely high concentrations of selenium it can cause reproductive failure and birth defects. For this TMDL, the water quality target for selenium is based upon the numerical criteria provided in FAC 62-302.530, where a percent reduction is calculated for each violation of the criteria, and then an average of all the reductions is determined. The TMDL for selenium is given as an overall percent reduction.

5.7. Iron

The water quality target for iron is the numeric criterion of less than or equal to one milligram per liter.

5.8. Lead

The water quality target for iron is the numeric criterion of less than or equal to one milligram per liter.

6. Water Quality Assessment

A water quality assessment was conducted to review all pertinent water quality data for the WBIDs in question in the Middle and Lower St. Johns River Basin. The constituents reviewed include nutrients, BOD, DO, fecal coliform, silver, selenium and iron.

6.1. Water Quality Data

For this effort, readily available water quality data and information have been assembled to support an up-to-date assessment of the water quality conditions and designated use support of the impaired segments within the Middle and Lower St. Johns River. Water quality data from two water quality databases were obtained from FDEP and the SJRWMD. Efforts were made to solicit additional readily available water quality data from other agencies and entities that have collected data within the watershed. The databases used for this analysis were the most complete and current sources of relevant water quality data. These data are available for download from the Florida Environmental Data Extraction Tool (FEDET) at the following address: http://fedet.tetratech-ffx.com/fedet/index.jsp. The water quality data used are provided in graphical format in the Appendices.

7. Source and Load Assessment

7.1. Nutrients

Nutrients enter surface waters from both point and nonpoint sources. Point sources are facilities that discharge at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. All point sources must have a National Pollutant Discharge Elimination System (NPDES) permit.

Point source contributions can typically be attributed to the following sources:

? Municipal wastewater facilities

? Municipal Separate Storm Sewers (MS4s)

Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. Nonpoint sources can be attributed in a variety of ways. However, one common approach is to estimate or calculate nonpoint source loads based on land use type. In this analysis, nonpoint sources are broken out and loads are calculated by land use category using the Florida Land Use, Cover, and Forms Classification System (FLUCCS) scheme (Table 2). Land use categories can be broken into nine primary categories, and then more refined classifications are available at the FLUCCS Level 2 and Level 3.

Table 2 Nonpoint Source Land Use Categories from FLUCCS Level 1 Classification Scheme

Land Use Category	FLUCCS Code
Urban and Built Up	1000
Agriculture	2000
Rangeland	3000
Upland Forests	4000
Water	5000
Wetlands	6000
Barren Land	7000
Transportation, Communications and Utilities	8000

In their PLSM calculations, SJRWMD aggregated components of the above landuses to better streamline the PLSM analysis (Hendrickson and Konwinski, 1998). To remain consistent with that approach, the nutrient and BOD loads calculated in this report were done the same way (Table 4).

7.2. Fecal Coliforms

Fecal coliform can be delivered to a stream through a wide variety of point and nonpoint sources. There are no known point sources within the Mill Branch watershed, so this source assessment focuses on likely nonpoint sources. Potential nonpoint sources of fecal coliform include domestic pets, animal feedlots, wildlife, septic systems, livestock, pastures, boat pumpouts, landfills and the land application of manure and sludge (EPA 2001). A review of 1995 land uses indicates that Mill Branch watershed contains a mixture of low and medium density residential, row crops, rangelands and forests. Thus, it is highly likely that fecal coliform sources in this watershed include everything from wildlife and domestic pets, to livestock and pastures, to failing septic systems and urban stormwater. It is unknown whether any of the local potato and cabbage farms are applying manure as a source of fertilizer, but it could be possible as a pre-plant practice. A review of available water quality and nearby flow data indicates violations of the fecal coliform criterion occur at both high and low flow conditions indicating there is no one source and mechanism responsible for delivering fecal coliform to Mill Branch.

7.3. Point Sources

7.3.1. Permitted Point Sources

There are 2 active domestic wastewater treatment facilities (WWTF) within the TMDL segments study drainage area (Figure 2 & Table 3). These are permitted through the National Pollutant Discharge Elimination System (NPDES) Program. The facilities within the watershed receive human waste from the collection system and typically provide secondary levels of treatment prior to discharge which reduces nutrient loads to some extent. There are also 3 other NPDES facilities that are located within the boundaries of the TMDL segments. All of these are listed in Table 3.

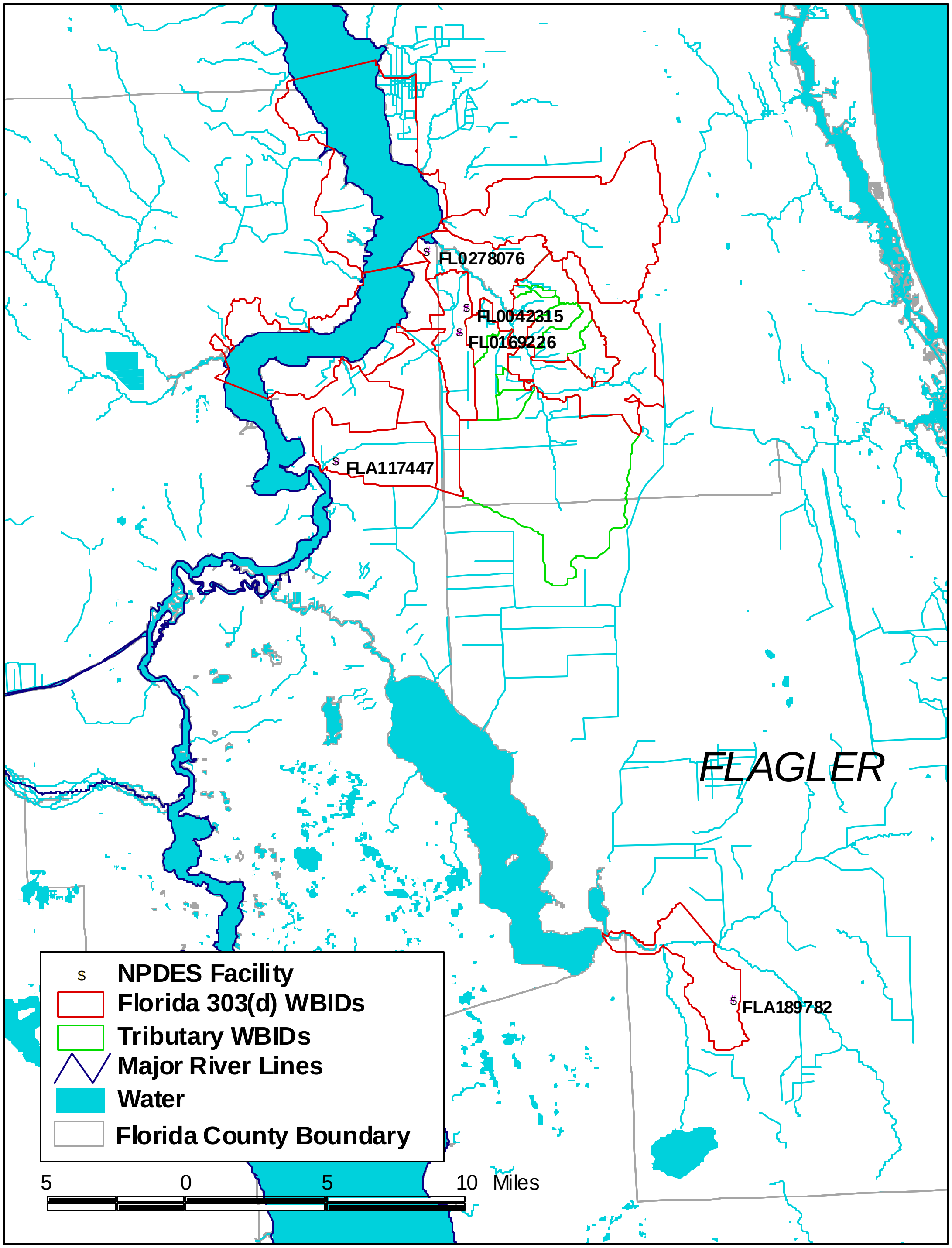

Figure 2 Point Source Discharger locations in St. Johns River Basin

Table 3 NPDES Permitted Facilities within the St. Johns River Basin

Facility Name	Facility ID	Permitted Discharge (mgd)	Permitted TN Concentrations (mg/l)	Permitted TP Concentrations (mg/l)	Permitted BOD Concentrations (mg/l)
HASTINGS WWTF	FL0042315	0.1200	9.0	Report Only	6.25
HASTINGS WTP - RO REJECT	FL0169226	0.0870	Report Only	Report Only	31.0
ANGUILLA FISH FARM	FL0278076	Unknown	---	---	Report Only
PUTNAM CORRECTIONAL WWTF (FDOC)	FLA117447	Unknown	---	---	---
COWART RANCH RESIDUALS MANAGEMENT FACILITY	FLA189782	Unknown	---	---	---

Discharge and permit limit data from the FDEP WAFR database were obtained and reviewed in order to calculate average annual permitted loads of BOD from the Hastings WWTF, located within WBID 2555. These permitted loads are incorporated in the wasteload allocation of the TMDL. Additional details regarding permit limits and discharges were not available from the FDEP WAFR database.

7.3.2. Municipal Separate Storm System Permits

Municipal Separate Storm Sewer Systems (MS4s) are point sources also regulated by the NPDES program. Discharge from storm water pipes or conveyances potentially include urban runoff high in bacteria and other pollutants. In 1990, EPA developed rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) storm water program, designed to prevent harmful pollutants from being washed by storm water runoff into Municipal Separate Storm Sewer Systems (MS4s) (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of “medium” and “large” MS4s (those generally serving populations of 100,000 or greater) to implement a storm water management program as a means to control polluted discharges from MS4s. Approved storm water management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES storm water program to certain “small” MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Storm Water Program. Only a select subset of small MS4s, referred to as “regulated small MS4s”, require an NPDES storm water permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of a UA that are designated by NPDES permitting authorities.

For the purpose of this TMDLs MS4 outfalls will have to meet the percent reductions as prescribed for the nonpoint sources. Best management practices will need to be developed to achieve the reductions in nutrients and sediments as prescribed by the TMDL.

7.4. Nonpoint Sources

Nonpoint sources contribute a greater annual load of nutrients into this region of the Middle and Lower St. Johns River basins than do point sources. Nonpoint sources represent contributions from diffuse sources, rather than from a defined outlet. On the land surface, nutrients accumulate over time from diverse sources such as dead plant matter, fertilizers, and atmospheric deposition. This accumulation of nutrients is washed from the land surface into the adjacent water body.

The land use distribution of the St. Johns River Basins provides insight into determining nonpoint sources of nutrients. Figure 3 displays land uses by WBID.

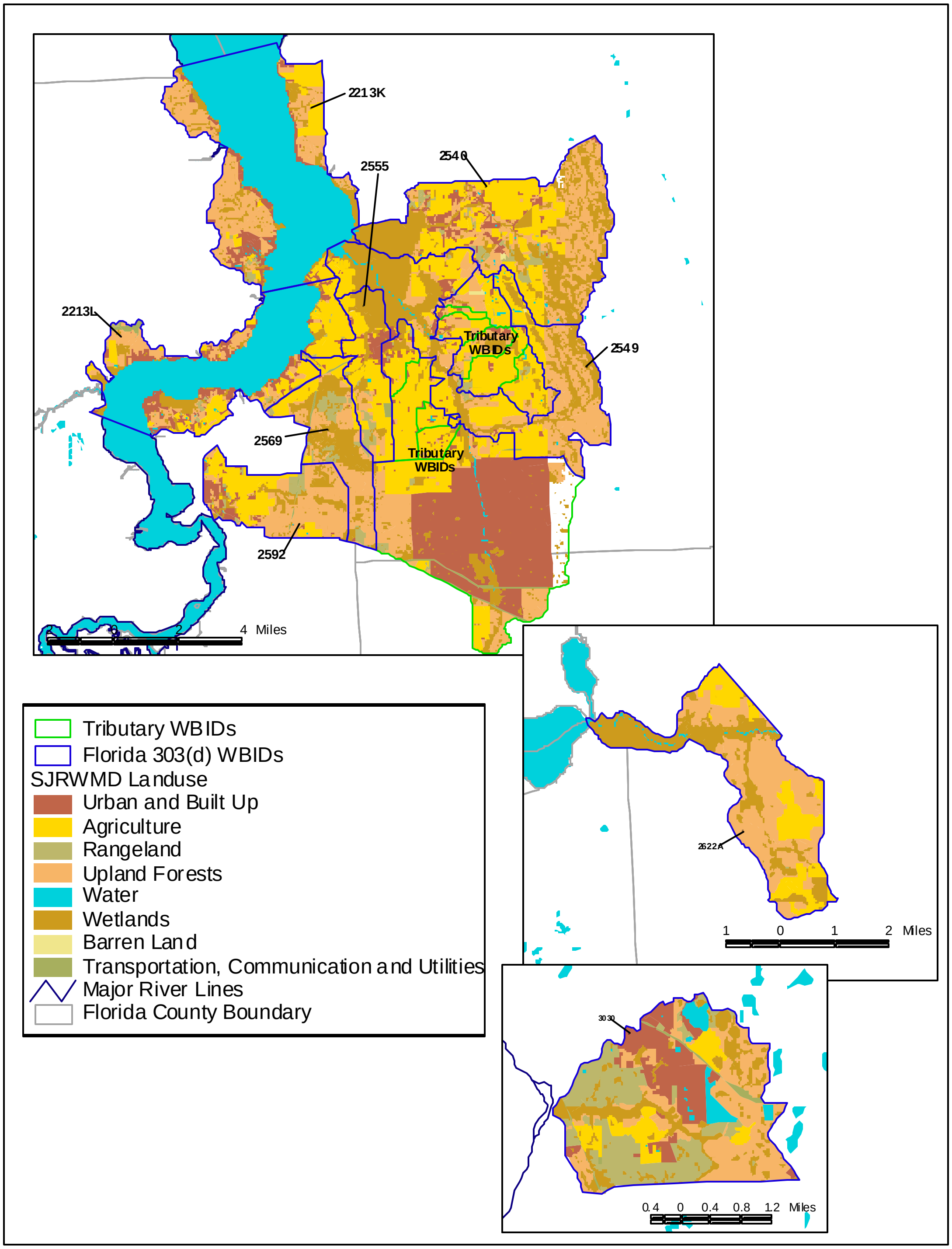

Figure 3 Land Uses within the LSJRB WB ID

7.4.1. Urban and Built Up Lands

Urban and built up lands include uses such as residential, industrial, extractive and commercial. Land uses in this category in the LSJR watershed have high total nitrogen event mean concentrations, average total phosphorus event mean concentrations and some of the highest BOD event mean concentrations. Urban and built land uses occur throughout the TMDL segments. For the purposes of the analysis conducted here, landuses designated transportation, communication and utilities have all been integrated into the urban and commercial landuses.

7.4.2. Agriculture

Agricultural lands include improved and unimproved pasture, row and field crops, citrus, and specialty farms. The highest total nitrogen and total phosphorus and BOD event mean concentrations in the watershed are associated with agricultural land uses.

7.4.3. Rangeland

Rangeland includes herbaceous, scrub, disturbed scrub and coastal scrub areas. Event mean concentrations for rangeland are about average for total nitrogen and low for total phosphorus. This landuse is aggregated with forests and barren lands.

7.4.4. Upland Forests

Upland Forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus, but high for BOD. This landuse is aggregated with rangeland and barren lands.

7.4.5. Water and Wetlands

Open water and wetlands occur in a significant portion of the Lower St. Johns TMDL segments and have very low event mean concentrations for nutrients, down to zero, but high for BOD.

7.4.6. Barren Land

Barren land includes beaches, borrow pits, disturbed lands and fill areas. Barren lands comprise only a small portion of the watershed and are aggregated along with forests and rangeland.

7.4.7. Transportation, Communications and Utilities

Transportation uses include airports, roads and railroads. Event mean concentrations in PLSM for these types of uses are in the mid range for total nitrogen and total phosphorus. For the purposes of the PLSM calculations, this landuse has been incorporated in with the urban and commercial landuses.

8. Modeling

Large watersheds with distinct subwatersheds, varied land uses and soil types, and numerous potential sources of pollutants require, at a minimum, a model or tool that allows one to consider the interaction of these factors in a spatially distributed context. These interactions have a significant influence on the total loads of the pollutants in question that are ultimately delivered to the system. The modeling approach that was applied to simulate nutrient loading to the St. Johns River Basin is described in this section.

8.1. Model Selection

Selection of the appropriate analytical tool for TMDL development was based on an evaluation of parameters of concern and the currently available and accepted modeling tools. The SJRWMD has developed modeling tools and an approach to address nutrient loading in the lower SJRB. EPA Region 4 recognizes the significant effort that has gone into developing these ongoing efforts and recommends a technical approach for this TMDL that is consistent with the WMDs approach. SJRWMD has developed a detailed modeling system that can estimate the delivery of nutrients from the tributaries into the main stem of the river and then simulate nutrient processes and cycling within the river itself. SJRWMD has developed and refined the Pollutant Load Screening Model (PLSM or "Plasm") which is a tool to help quantify nonpoint source loads associated with average annual runoff. PLSM has been used by SJRWMD to develop seasonal nutrient import-export budgets for the Lower St. Johns River. These were expressed as allowable average annual loads of total nitrogen and total phosphorus.

8.2. Model Set Up

PLSM was originally developed to support planning level analyses for SJRWMD in 1995 and 1996. Since that time the model has been refined and improved for the St. Johns River Basin in support of the Seasonal Nutrient Import-Export Budgets for the Lower St. Johns River. PLSM is a spatially distributed GIS-based model that uses soil types, land uses and precipitation to generate loads per acre of total nitrogen, total phosphorus and TSS. Figure 4 displays the computational framework of PLSM (Mundy and Bergman, 1998).

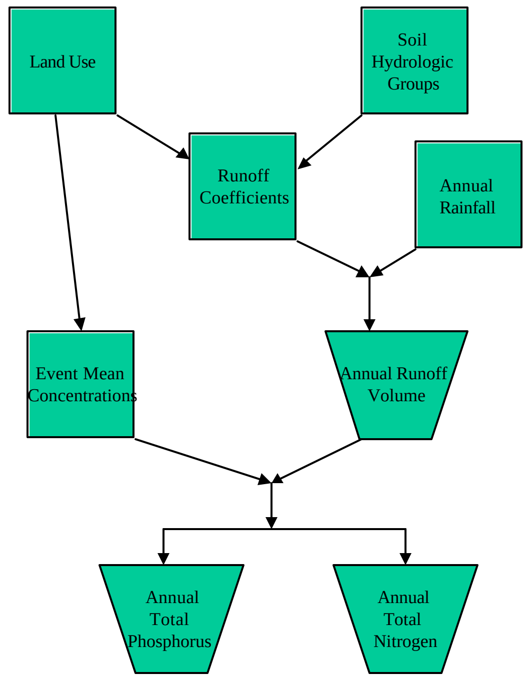

Figure 4 PLSM Computational Framework

8.2.1. Soils

The soil data layer is the Soil Survey Geographic Database (SSURGO) developed by the Natural Resource Conservation Service. Soils are classified based on their hydrologic group rating of A. B, C, D, B/D, C/D, U, W and X. Groups U, W and X soils were assigned the mean of the runoff coefficient for the four groups. B/D and C/D soils were assigned the D coefficient where lands are undeveloped and the B or C coefficient where developed.

8.2.2. Land Use

Land uses to calculate the current loads are based on the SJRWMD 1995 FLUCCS land uses coverages. Certain aggregations in landuse types were made to allow a less complex, targeted analysis using PLSM. An example of such an aggregation is where landuses designated transportation were included with high intensity commercial areas. A complete list is included as part of Table 5.

8.2.3. Precipitation

Rainfall data was obtained through the SJRWMD Seasonal Nutrient Budgets for LSJR (Hendrickson and Konwinski, 1998), in which long-term seasonal means were provided.

8.2.4. Hydrologic Boundaries

For current loads, the hydrologic boundaries used are the same as those of the FDEP segments on which TMDLs are to be conducted. This allows consistency between the individual TMDL efforts of FDEP and EPA and should hopefully encourage cooperation with local entities and the FDEP during the implementation phase.

8.2.5. Runoff Coefficients

SJRWMD has defined runoff coefficients based on the combination of soil type and land uses. Runoff coefficients are multiplied by annual rainfall to determine an annual runoff volume from a particular parcel. Table 4 displays the runoff coefficients that were used to generate the current loads based on 1995 land uses. These runoff coefficients are derived from numerous standard references and additional local studies and reflect a serious effort by SJRWMD to improve the PLSM model.

8.2.6. Event Mean Concentrations

Event mean concentrations are applied to the annual average runoff volume to calculate an average annual total nitrogen or total phosphorus load for that parcel. The event mean concentration reflects the average concentration of a parameter that would be found in surface water running off from a parcel of land with a consistent land use. The sum of all loads within a drainage basin is calculated to develop a total annual load of total nitrogen, total phosphorus and BOD and an average annual load per acre for a watershed. Table 4 displays the runoff coefficients for the current load scenario, while Table 5 lists the event mean concentrations used in PLSM, by season.

Table 4 PLSM Runoff Coefficients for Calculating Current (1995) Loads

Landuse	FLUCCS Codes Included	Runoff Coefficients						
		A	B	C	D	B/D	C/D	U, W, X
Season 1: December through March								
Low Density Residential	1000-1199, 1480-1489	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Medium Density Residential	1200-1299, 1820-1829	0.5	0.6	0.7	0.8	0.7	0.75	0.65
High Density Residential	1300-1399	0.6	0.7	0.8	0.9	0.8	0.85	0.75
Low Intensity Commercial	1700-1799	0.5	0.6	0.7	0.8	0.7	0.75	0.65
High Intensity Commercial	1400-1479, 1490-1499, 8000-8199	0.7	0.8	0.9	1	0.9	0.95	0.85

Landuse	FLUCCS Codes Included	Runoff Coefficients						
		A	B	C	D	B/D	C/D	U, W, X
Industrial	1500-1599, 8200-8319, 8330-8999	0.5	0.6	0.7	0.8	0.7	0.75	0.65
Mining	1600-1699	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Pasture	2000-2119, 2120-2139	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Row Crops	2140-2199	0.401	0.401	0.401	0.401	0.401	0.401	0.401
Citrus	2200-2399	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Livestock Feedlots	2300-2399, 2520-2539	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0.05	0.12	0.18	0.25	0.185	0.215	0.15
Water Surfaces	5000-5999	1	1	1	1	1	1	1
Wetlands	6000-6999	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Season 2: April through July								
Low Density Residential	1000-1199, 1480-1489	0	0	0.05	0.1	0.05	0.075	0.0375
Medium Density Residential	1200-1299, 1820-1829	0.2	0.3	0.4	0.5	0.4	0.45	0.35
High Density Residential	1300-1399	0.3	0.4	0.5	0.6	0.5	0.55	0.45
Low Intensity Commercial	1700-1799	0.2	0.3	0.4	0.5	0.4	0.45	0.35
High Intensity Commercial	1400-1479, 1490-1499, 8000-8199	0.4	0.5	0.6	0.7	0.6	0.65	0.55
Industrial	1500-1599, 8200-	0.2	0.3	0.4	0.5	0.4	0.45	0.35

Landuse	FLUCCS Codes Included	Runoff Coefficients						
		A	B	C	D	B/D	C/D	U, W, X
	8319, 8330-8999							
Mining	1600-1699	0	0	0.05	0.1	0.05	0.075	0.0375
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	0	0	0.05	0.1	0.05	0.075	0.0375
Pasture	2000-2119, 2120-2139	0	0	0.05	0.1	0.05	0.075	0.0375
Row Crops	2140-2199	0.392	0.392	0.392	0.392	0.392	0.392	0.392
Citrus	2200-2399	0	0	0.05	0.1	0.05	0.075	0.0375
Livestock Feedlots	2300-2399, 2520-2539	0	0	0.05	0.1	0.05	0.075	0.0375
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0	0	0.05	0.1	0.05	0.075	0.0375
Water Surfaces	5000-5999	1	1	1	1	1	1	1
Wetlands	6000-6999	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Season 3: August through November								
Low Density Residential	1000-1199, 1480-1489	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Medium Density Residential	1200-1299, 1820-1829	0.55	0.65	0.75	0.85	0.75	0.8	0.7
High Density Residential	1300-1399	0.65	0.75	0.85	0.95	0.85	0.9	0.8
Low Intensity Commercial	1700-1799	0.55	0.65	0.75	0.85	0.75	0.8	0.7
High Intensity Commercial	1400-1479, 1490-1499, 8000-8199	0.7	0.8	0.9	1	0.9	0.95	0.85
Industrial	1500-1599, 8200-8319, 8330-8999	0.55	0.65	0.75	0.85	0.75	0.8	0.7

Landuse	FLUCCS Codes Included	Runoff Coefficients						
		A	B	C	D	B/D	C/D	U, W, X
Mining	1600-1699	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Pasture	2000-2119, 2120-2139	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Row Crops	2140-2199	0.512	0.512	0.512	0.512	0.512	0.512	0.512
Citrus	2200-2399	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Livestock Feedlots	2300-2399, 2520-2539	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0.05	0.15	0.25	0.35	0.25	0.3	0.2
Water Surfaces	5000-5999	1	1	1	1	1	1	1
Wetlands	6000-6999	1	1	1	1	1	1	1

Table 5 PLSM Event Mean Concentrations for Current Loads Scenario

Land Use	FLUCCS Code Used	Nutrient Concentrations mg/l		
		TN	TP	BOD
Season 1: December through March				
Low Density Residential	1000-1199, 1480-1489	0.8	0.08	1
Medium Density Residential	1200-1299, 1820-1829	1.4	0.25	2
High Density Residential	1300-1399	1.8	0.3	4
Low Intensity Commercial	1700-1799	1.1	0.2	2
High Intensity Commercial	1400-1479, 1490-1499	1.8	0.3	4
Industrial	1500-1599, 8200-8319, 8330-	1.2	0.25	2

Land Use	FLUCCS Code Used	Nutrient Concentrations mg/l		
		TN	TP	BOD
	8999			
Mining	1600-1699	0.7	0.06	1
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	2.32	0.34	3.8
Pasture	2000-2119, 2120-2139	3.9	0.75	4
Row Crops	2140-2199	2	0.38	1
Citrus	2200-2399	2.05	0.14	2.6
Livestock Feedlots	2300-2399, 2520-2539	4.5	1.3	6
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0.7	0.06	1
Water Surfaces	5000-5999	0.28	0.017	0
Wetlands	6000-6999	0.7	0.06	1
Season 2: April through July				
Low Density Residential	1000-1199, 1480-1489	0.8	0.07	1
Medium Density Residential	1200-1299, 1820-1829	1.6	0.3	2
High Density Residential	1300-1399	2	0.5	4
Low Intensity Commercial	1700-1799	1.2	0.3	2
High Intensity Commercial	1400-1479, 1490-1499	2	0.5	4
Industrial	1500-1599, 8200-8319, 8330-8999	1.2	0.3	2
Mining	1600-1699	0.7	0.05	1
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	2.32	0.34	3.8
Pasture	2000-2119, 2120-2139	3	1.1	4
Row Crops	2140-2199	10.7	1.8	1
Citrus	2200-2399	2.05	0.14	2.6
Livestock Feedlots	2300-2399, 2520-2539	6	1.3	6

Land Use	FLUCCS Code Used	Nutrient Concentrations mg/l		
		TN	TP	BOD
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0.7	0.05	1
Water Surfaces	5000-5999	0.49	0.014	0
Wetlands	6000-6999	0.7	0.05	1
Season 3: August through November				
Low Density Residential	1000-1199, 1480-1489	0.8	0.09	1
Medium Density Residential	1200-1299, 1820-1829	1.5	0.35	2
High Density Residential	1300-1399	1.7	0.53	4
Low Intensity Commercial	1700-1799	1.3	0.22	2
High Intensity Commercial	1400-1479, 1490-1499	1.7	0.53	4
Industrial	1500-1599, 8200-8319, 8330-8999	1.3	0.22	2
Mining	1600-1699	0.7	0.07	1
Miscellaneous Agriculture	2240-2299, 2400-2519, 2540-2599	2.32	0.34	3.8
Pasture	2000-2119, 2120-2139	3	2	4
Row Crops	2140-2199	4.4	2.2	1
Citrus	2200-2399	2.05	0.14	2.6
Livestock Feedlots	2300-2399, 2520-2539	5	2.6	6
Forestry, Silviculture, Rangeland, Barren	1800-1819, 1830-1999, 2600-3999, 4000-4399, 4400-4999, 7000-7399, 7400-7999, 8320-8329	0.7	0.07	1
Water Surfaces	5000-5999	0.47	0.028	0
Wetlands	6000-6999	0.7	0.07	1

8.3. Model Calibration

The PLSM pollutant loading coefficients were calibrated to the tributary flow-weighted water quality concentration data set using a least-squares regression approach. To do this, landuses were simplified into four categories: residential/urban, row crop, dairy and pasture, and undeveloped. Multiple regressions were run for each water quality calibration station relating the fraction of aerial cover of each of the four aggregated landuses within a calibration basin to the flow-weighted water quality constituent concentration as calculated for the catchment terminus. In addition to the regressions, simultaneous equations were solved in many instances between calibration basins of different predominant landuse types, which were used to compare to the regression approach results or to directly supply coefficients when the multiple regression approach produced independent variable estimators less than zero. (Hendrickson and Konwinski, 1998)

8.4. Modeling Results

8.4.1. Point Sources

Available discharge data and permit limit information was used to calculate permitted annual BOD loads coming from NPDES dischargers within the Middle and Lower St. Johns River TMDL segments (Table 6). Total Nitrogen and Total phosphorus annual loads from the facilities were obtained from the draft FDEP Lower St. Johns River TMDL document (Magley and Joyner, draft). The total annual loads of total nitrogen, total phosphorus and BOD from point sources are significantly smaller than the estimated total average annual loads from nonpoint sources within the St. Johns River Basins.

Table 6 Permitted Annual TN and TP Loads from WWTP within SJR watershed

Facility ID	Facility Name	Average Annual Flow (mgd)	Permitted TN Load (lb/yr)	Permitted TP Load (lb/yr)	Permitted BOD Load (lb/yr)
FL0042315	HASTINGS WWTF	0.12	1417	185	2284
FL0169226	HASTINGS WTP - RO REJECT	0.045	Report Only	Report Only	4238
FL0278076	ANGUILLA FISH FARM	1.314	---	---	Report Only
FLA117447	PUTNAM CORRECTIONAL WWTF (FDOC)	---	---	---	---
FLA189782	COWART RANCH RESIDUALS MANAGEMENT FACILITY	---	---	---	---

8.4.2. Nonpoint Sources

A review of estimated loads from PLSM indicates that absolute total nitrogen, total phosphorus and BOD loads and loading rates per acre are highly variable throughout the St. Johns River basins (Table 7, Figure 5, Figure 6). The Cracker Branch segment (WBID 2555) appears to have the highest per acre loading rates of total nitrogen, total phosphorus and BOD. A significant portion of this segments landuse is designated as agricultural, with medium density residential areas. Long Branch (WBID 3030) has the lowest per acre loading rates of total nitrogen and total phosphorus. Not surprisingly, this area contains a large proportion of wetlands and forested, undeveloped lands. A small proportion of this WBID is urbanized, though not very heavily at all. In terms of total average annual loads (Table 7), WBID 2540 and WBID 2549 contribute the greatest nutrient and BOD loads, though they are also some of the largest WBIDs considered here.

Also, loads have been calculated for a number of segments for which TMDLs are not required by the 1998 303(d) list. These segments, collectively labeled the 'Tributary WBIDs', contribute significant amounts of nutrient and BOD loads to the Deep Creek (WBID 2549) segment. As the TMDL for Deep Creek has to address nutrients and BOD, it was found necessary to account for the loads it received from upstream tributaries, and to assign a suggested load allocation for the tributaries themselves. In this way, though these tributaries were not classified as impaired themselves, they have been addressed as a relevant source of nutrient loads to Deep Creek.

Table 7 PLSM Estimated Current (1995) Average Annual TN, TP and BOD (lbs) Nonpoint Loads by WBID

TMDL WBID	Area (acres)	Annual TN Load	TN Load per acre	Annual TP Load	TP Load per acre	Annual BOD Load	BOD Load per acre
2540	14216	116671	8.21	26715	1.88	59496	4.19
2549	13360	118080	8.84	27149	2.03	58229	4.36
2555	3720	43759	11.76	10958	2.95	19351	5.20
2569	5201	31524	6.06	6417	1.23	21891	4.21
2592	5537	41208	7.44	9999	1.81	20664	3.73
2622A	5494	21350	3.89	4438	0.81	23257	4.23
3030	3628	11028	3.04	2008	0.55	14298	3.94
Tributary WBIDs	26892	213043	7.92	52783	1.96	77047	2.87

Figure 5 shows the estimate of total nitrogen and total phosphorus loads per acre to the Middle and Lower St. Johns River, by TMDL WBIDs.

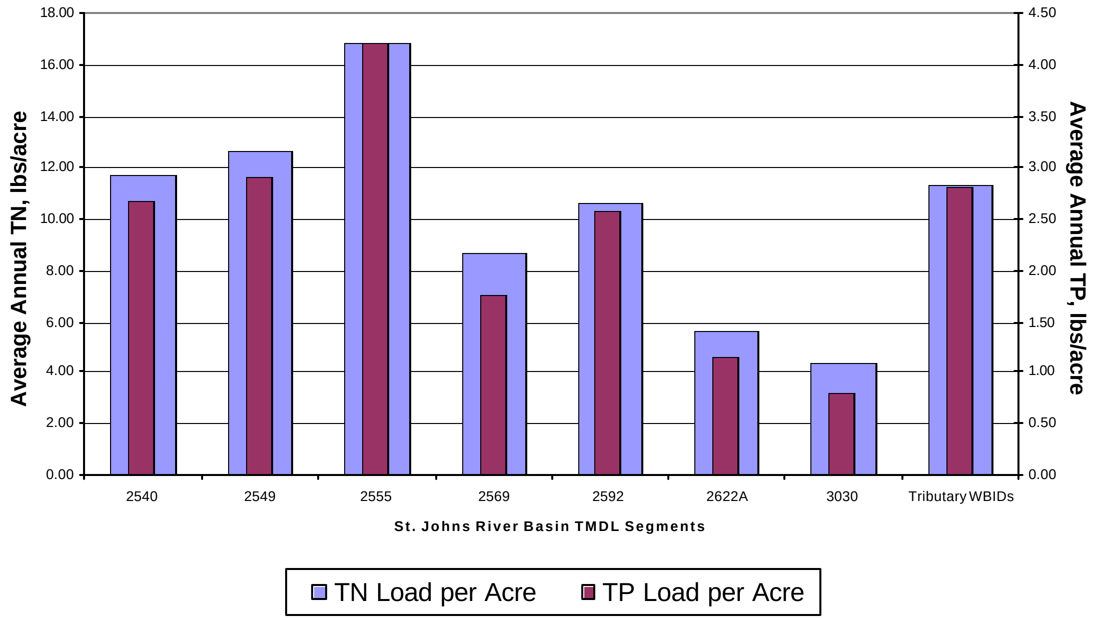

Figure 5 Estimated Annual Loads of TN and TP per acre by TMDL Segment

Figure 6 shows the estimate of BOD loads per acre to the Middle and Lower St. Johns River, by TMDL WBIDs.

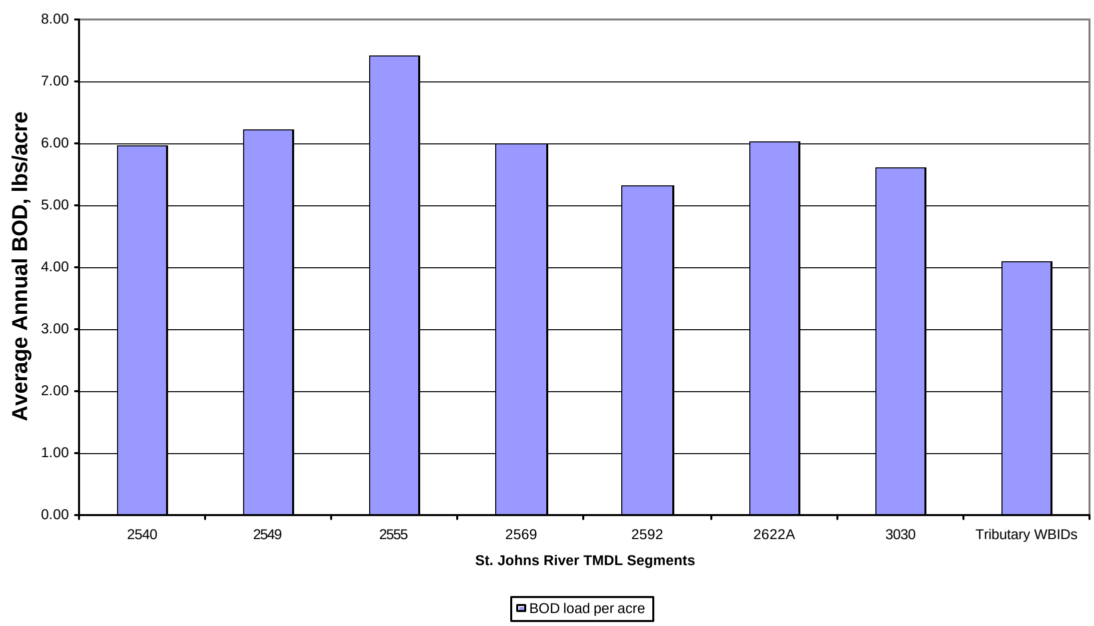

Figure 6 Estimated Average Annual BOD Load per acre by TMDL Segment

8.4.3. Fecal Coliforms

Fecal coliform loads in Mill Branch were calculated using the EPA Region 4 recommended loading curve approach. Daily average flow data from 1992 to 2002 from the USGS gauge on Deep Creek at Spuds (#022452560) were used to generate a proportioned load duration curve for Mill Branch. Measured flows were multiplied by the fecal coliform criterion in order to calculate the allowable load in billions of cfu per day ("TMDL Fecal Load" curve). Fecal coliform counts measured between 1993 and 2002 at the lower end of Mill Branch near its outlet to the St. Johns River were plotted based on the estimated flow when the sample was taken. A best fit line was then drawn between the measured violations ("Expon (Violations)") in order to calculate the current fecal coliform loads in Mill Branch (Figure 7).

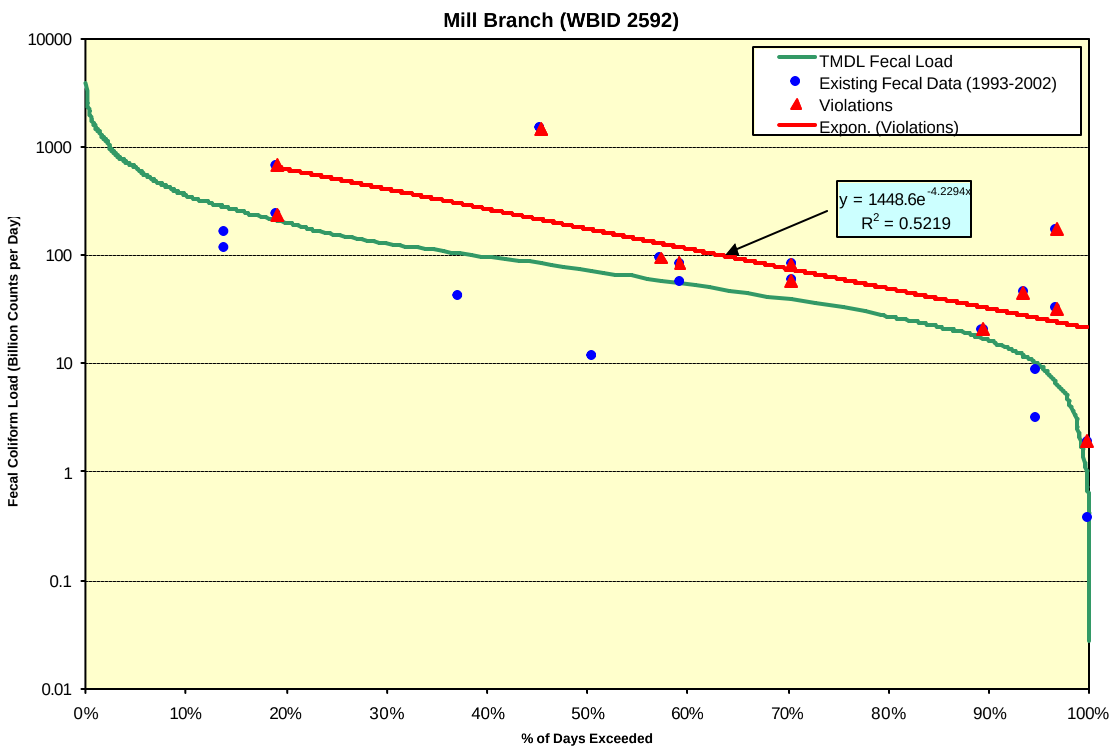

Figure 7 Load Duration Curve for Fecal Coliform in Mill Branch

As Figure 7 indicates, fecal coliform violations can be expected across high and low flow conditions within the watershed. Table 8 shows the current fecal coliform load in Mill Branch using the load duration curve approach. The average daily value of 2.7046E+11 is the current or existing daily load for TMDL purposes.

Table 8 Current Fecal Coliform Load in Mill Branch

% Flow Exceedance	Existing Load (counts per day)
10%	9.4900E+11
15%	7.6812E+11
20%	6.2171E+11
25%	5.0321E+11
30%	4.0729E+11
35%	3.2966E+11
40%	2.6682E+11
45%	2.1597E+11
50%	1.7480E+11
55%	1.4148E+11
60%	1.1452E+11
65%	9.2688E+10
70%	7.5021E+10
75%	6.0722E+10
80%	4.9148E+10
85%	3.9780E+10
90%	3.2198E+10
95%	2.6061E+10

8.4.4. Metals

This section of the report deals with the development of TMDLs for various metals in the study area. As in previously shown in Table 1, TMDLs are required for silver for WBIDs 2213K, 2213L, 2540, 2549, 2569 and 2622A. Iron TMDLs are required for WBIDs 2540, 2569, 2549 and 2622A. Selenium and lead TMDLs are required for WBID 2622A. Table 9 provides a list of water quality monitoring stations for each WBID and with the data collection period of record used in the assessment.

Table 9 Metals Water Quality Observations used in the Assessment of TMDL WBIDs

WBID	TMDL Parameter	Station	First Date	Last Date
2213K	Silver	21FLSJWMSJM37	12/15/1993	8/12/2002
		21FLSJWMSRP	11/13/1990	8/12/2002
2213L	Silver	21FLSJWMSJRCC	12/15/1993	8/12/2002
		21FLSJWMSJRCE	12/15/1993	10/9/2001
		21FLSJWMSJRCW	12/15/1993	8/12/2002
2540	Iron	21FLSJWMMOB	2/11/1992	10/28/1992
		21FLSJWMMOB.S	4/6/1995	4/6/1995
2540	Silver	21FLSJWMMOB	2/11/1992	8/8/2002
		21FLSJWMMOB2	2/7/1997	8/7/2002
2549	Silver, Iron	21FLSJWMDCR	8/24/1995	10/15/1995
		21FLSJWMDPB	12/15/1993	9/15/2002
		21FLSJWMDSJ	11/30/1990	11/30/1990
2569	Iron	21FLSJWMOHD	2/11/1992	4/6/1995
		21FLSJWMOHD.S	4/6/1995	4/6/1995
2569	Silver	21FLSJWMOHD	2/11/1992	8/7/2002
2622A	Iron	21FLSJWMHAW	3/14/1991	10/16/2001
2622A	Selenium	21FLSJWMHAW	8/1/1989	10/16/2001
2622A	Lead	21FLSJWMHAW	8/1/1989	10/16/2001
2622A	Silver	21FLSJWMHAW	12/1/1993	4/26/1995

9. TMDL

A total maximum daily load (TMDL) for a given pollutant and waterbody is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

TMDL = ? ?WLAs + ? ?LAs + MOS

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards. A portion of the TMDL allocated to each of the pollutant sources as WLA for point source and LA for non point source. The allocations for all pollutant sources are identified that cumulatively provide for the basis for the State or WMD to prescribe controls that will ultimately achieve water quality standards. For nutrients, TMDLs can be expressed on a mass loading basis (e.g., pounds per day or year).

9.1. Critical Conditions

EPA regulations at 40 CFR 130.7(c)(1) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition here is the ability to use seasonal long-term mean rainfall values, runoff coefficients and event mean concentrations. The availability of this information provides loading information faithful to seasonal fluctuations in environmental conditions, thus providing sound loading values through PLSM. Current loads to the Middle and Lower St. Johns River basin were determined based on 1995 land uses which is close to the time when the WBIDs were originally listed. Average annual loads provide a useful indication of the overall nutrient and BOD loads being contributed to the Middle and Lower St. Johns River watershed.

9.2. Margin of Safety

There are two methods for incorporating the MOS (USEPA, 1991):

? Implicitly incorporate the MOS using conservative model assumptions to develop allocations

? Explicitly specify a portion of the total TMDL as the MOS and use the remainder for Allocations

For the Middle and Lower St. Johns River nutrient and BOD TMDLs, an implicit margin of safety was applied. This was accomplished in the following ways:

? In establishing a 30% reduction for TN and TP, the FDEP TMDL for the Lower St. Johns River employed conservative decisions with respect to modeling assumptions, development of site-specific alternative water quality targets and development of the assimilative capacity. By adopting similar reductions for this report and also applying it to BOD allocations, this analysis inherits the implicit MOS.

? In the FDEP TMDL document for the LSJR, it was clear that though both nutrients may not be limiting factors, both were given equal reductions. These reductions were based on meeting targets within all of the WBIDs of concern, and so the amount of reduction was based directly on the worst case WBID in the mainstem. As such, by applying similar reductions in this report, an implicit MOS has been acknowledged.

? NPDES permitted facilities were represented in the model using maximum permitted discharges.

9.3. Seasonal Variability

Seasonality is incorporated in this TMDL through the use of annual average loads and seasonal event mean concentrations and runoff coefficients. This approach includes both the influences of wet and dry weather conditions on loadings to the waterbody. Furthermore, the use of multi-year analysis in the development of current loadings incorporates a range of wet and dry years.

9.4. Load Allocation

The TMDLs and their components (WLA, LA, and MOS) were derived based on an interpretation of the model results and water quality standards. The TMDLs are presented below for total nitrogen, total phosphorus and BOD for the entire study area, and are calculated to achieve the narrative nutrient criteria. Achieving the narrative nutrient criteria will also result in achieving appropriate dissolved oxygen and chlorophyll regimes as these impairments are a direct result of symptoms associated with cultural eutrophication caused by nutrient enrichment.

Nitrogen TMDL = ? ?WLAs + ? ?LAs + MOS

TMDL = 1,631 lbs/year TN + 596,663 lbs/yr TN + implicit MOS

Total Nitrogen TMDL = 598,294 lbs/year Total Nitrogen

Phosphorus TMDL = ? ?WLAs + ? ?LAs + MOS

TMDL = 185 lbs/year TP + 140,467 lbs/yr TP + implicit MOS

Total Phosphorus TMDL = 140,652 lbs/year Total Phosphorus

Biochemical Oxygen Demand TMDL = ? ?WLAs + ? ?LAs + MOS

TMDL = 18,395 lbs/year BOD + 294,233 lbs/yr BOD + implicit MOS

BOD TMDL = 312,628 lbs/year BOD

9.5. Wasteload Allocations

9.5.1. NPDES Dischargers

Table 10 presents the sum of the NPDES permitted facilities and their allocated total nitrogen, total phosphorus and biochemical oxygen demand loading. The allocation for TN and TP is based on the calculated average annual discharge times the maximum permitted total nitrogen and total phosphorus and BOD concentrations for the NPDES permitted facilities.

Table 10 Waste load allocations (WLAs) for NPDES permitted facilities in IRL watershed

NPDES Permit	Facility Name	WBID	Average Annual TN Load (pounds)	Average Annual TP Load (pounds)	Average Annual BOD Load (pounds)
FL0042315	*HASTINGS WWTF*	*2555*	*1417*	*185*	*2284*
FL0169226	*HASTINGS WTP - RO REJECT*	*2555*	*214*	---	---
FL0278076	*ANGUILLA FISH FARM*	*2549*	---	---	*16110*
FLA117447	*PUTNAM CORRECTIONAL WWTF (FDOC)*	*2592*	---	---	---
FLA189782	*COWART RANCH RESIDUALS MANAGEMENT FACILITY*	*2622A*	---	---	---

9.5.2. Municipal Separate Storm System Permits

The MS4 waste load allocation is expressed as a percent reduction that is equivalent with the load allocation. The MS4 Phase I service areas included in this TMDL are: Flagler County, St. Johns County, Putnam County, Volusia County and Orange County. Best management practices for the MS4 service area should be developed to meet the percent reduction for both nitrogen and phosphorus of 30%.

9.6. Load Allocations

9.6.1. Nutrients and BOD

Load allocations were made by WBID (Table 11). Allocating in this way allows local and regional governments to work cooperatively to devise the most cost effective sub-basin specific load reduction plans that achieve maximum load reductions for the least amount of money. An overall reduction of 30% was applied to the current total nitrogen, total phosphorus and BOD loads, as was done in the FDEP St. Johns River TMDL (Magley and Joyner, draft)

Table 11 Nutrients and BOD Load Allocations for TMDL WBIDs

TMDL WBIDs	Area (acres)	Allocated Annual TN Load (pounds)	Allocated TN Load per acre (pounds)	Allocated Annual TP Load (pounds)	Allocated TP Load per acre (pounds)	Allocated Annual BOD Load (pounds)	Allocated BOD Load per acre (pounds)
2540	14216	116671	8.21	26715	1.88	59496	4.19
2549	13360	118080	8.84	27149	2.03	58229	4.36
2555	3720	43759	11.76	10958	2.95	19351	5.20
2569	5201	31524	6.06	6417	1.23	21891	4.21
2592	5537	41208	7.44	9999	1.81	20664	3.73
2622A	5494	21350	3.89	4438	0.81	23257	4.23
3030	3628	11028	3.04	2008	0.55	14298	3.94
Tributary WBIDs	26892	213043	7.92	52783	1.96	77047	2.87

9.6.2. Fecal Coliforms

There are no known point sources of fecal coliform in Mill Branch (2592), therefore there is no wasteload allocation. The load allocation is the average daily fecal coliform count between the 10^{th} and 95^{th} percentile flows derived from the load duration curve, or 9.9578E+10 counts per day (Table 12). The margin of safety for this TMDL is implicit because the loads are based on instream measurements that account for dilution and do not represent the maximum load that can be transported to the stream from the watershed. Critical conditions for the fecal coliform TMDL cover the range of flows between the 10^{th} and 95^{th} percentile of measured flows. Extreme low flow or drought periods and wet weather floods are not included in the calculations.

Table 12 TMDL for Fecal Coliform in Mill Branch

Wasteload Allocation	Load Allocation	Margin of Safety	TMDL
0	9.9578E+10 counts per day	Implicit	9.9578E+10 counts per day

9.6.3. Metals

Table 13 below provides a summary of the percent reductions calculated for metals data obtained through FDEPs Impaired Waters Analysis, version 8.2. For each violation of the criteria provided in FAC 62-302.530, a percent reduction was calculated according to the specific criteria for that parameter. An average percent reduction was then calculated by taking the mean value of all of these individual reductions for that specific metal.

Table 13 Average Percent Reductions for Metals TMDLs

WBID	Parameter	Observations	Violations	Florida Criteria	Average Percent Reduction
2213K	Silver	145	42	0.07	55.1
2213L	Silver	208	69	0.07	60.0
2540	Iron	6	4	1.0	37.3
2540	Silver	48	13	0.07	50.7
2549	Silver	78	24	0.07	62.1
2569	Iron	5	4	1.0	48.8
2569	Silver	25	6	0.07	86.5
2549	Iron	111	17	1.00	85.2
2622A	Selenium	49	9	5	70.7
2622A	Silver	9	2	0.07	56.2
2622A	Iron	57	22	1.0	32.9
2622A	Lead	51	33	$e^{(1.273[\ln H]-4.705)}$	61.8

9.7. TMDL Summary by WBID

Table 14 through Table 22 individually present the impaired WBIDs within the St. Johns River, as previously shown in Table 1, with their respective parameters of concern. For each parameter, the individual calculated TMDL is provided.

Table 14 for WBID 2213K

WBID 2213K TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Silver	---	55.1 %	implicit	55.1 %

Table 15 TMDLs for WBID 2213L

WBID 2213L TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Silver	---	60.0 %	implicit	60.0 %

Table 16 TMDLs for WBID 2540

WBID 2540 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
BOD	---	59,496 lbs/yr	implicit	59,496 lbs/yr
DO	---	---	---	Addressed by BOD TMDL
Iron	---	37.3 %	implicit	37.3 %
Silver	---	50.7 %	implicit	50.7 %

Table 17 TMDLs for WBID 2549

WBID 2549 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	---	118,080 lbs/yr	implicit	118,080 lbs/yr
Total Phosphorus	---	27,149 lbs/yr	implicit	27,149 lbs/yr
BOD	16,110 lbs/yr	58,229 lbs/yr	implicit	74,339 lbs/yr
DO	---	---	---	Addressed by BOD TMDL
Silver	---	62.1 %	implicit	62.1 %
Iron		57%	implicit	57%

Table 18 TMDLs for WBID 2555

WBID 2555 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	1,417 lbs/yr	43,759 lbs/yr	implicit	45,176 lbs/yr
Total Phosphorus	185 lbs/yr	10,958 lbs/yr	implicit	11,143 lbs/yr
BOD	2,285 lbs/yr	19,351 lbs/yr	implicit	21,635 lbs/yr
DO	---	---	---	Addressed by BOD TMDL

Table 19 TMDLs for WBID 2569

WBID 2569 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	---	31,524 lbs/yr	implicit	31,524 lbs/yr
Total Phosphorus	---	6,417 lbs/yr	implicit	6,417 lbs/yr
BOD	---	21.891 lbs/yr	implicit	21.891 lbs/yr
Silver	---	86.5 %	implicit	86.5 %
Iron	---	48.8 %	implicit	48.8 %

Table 20 TMDLs for WBID 2592

WBID 2592 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	---	41,208 lbs/yr	implicit	41,208 lbs/yr
Total Phosphorus	---	9,999 lbs/yr	implicit	9,999 lbs/yr
BOD	---	20,664 lbs/yr	implicit	20,664 lbs/yr
DO	---	---	---	Addressed by Nutrient and BOD TMDLs
Fecal Coliforms	---	9.9578E+10 counts/day	implicit	9.9578E+10 counts/day

Table 21 TMDLs for WBID 2622A

WBID 2622A TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	---	21,350 lbs/yr	implicit	21,350 lbs/yr
Total Phosphorus	---	4,438 lbs/yr	implicit	4,438 lbs/yr
BOD	---	23,257 lbs/yr	implicit	23,257 lbs/yr
DO	---	---	---	Addressed by Nutrient and BOD TMDLs
Selenium	---	70.7 %	implicit	70.7 %
Lead	---	56.2 %	implicit	56.2 %
Iron	---	32.9 %	implicit	32.9 %
Silver	---	61.8 %	implicit	61.8 %

Table 22 TMDLs for WBID 3030

WBID 3030 TMDL Parameters	Waste Load Allocations (WLAs)	Load Allocations (LAs)	Margin of Safety (MOS)	TMDL (WLAs+LAs+MOS)
Total Nitrogen	---	11,028 lbs/yr	implicit	11,028 lbs/yr
Total Phosphorus	---	2,008 lbs/yr	implicit	2,008 lbs/yr
BOD	---	14,298 lbs/yr	implicit	14,298 lbs/yr
DO	---	---	---	Addressed by BOD TMDL

10. References

Hendrickson, J. and Konwinski, J., 1998. Seasonal Nutrients Import-Export Budgets for the Lower St. Johns River, Florida. Florida Department of Environmental Protection and S. Johns River Waqter Management District.

Magley, W. and Joyner, D., 2003 draft. Total Maximum Daily Load for Nutrients For the Lower St. Johns River. Florida Department of Environmental Protection.

Mundy, Christine A and Bergman, M.J., 1998. The Pollution Load Screening Model: A Tool for the 1995 District Water Management Plan and the 1996 Local Government Water Resource Atlases. Technical Memorandum No. 29, St. Johns River Water Management District, Palatka, Florida.

Pandit, Ashok and Gopalakrishnan, 1997. Estimation of Annual Pollutant Loads under Wet Weather Conditions. Journal of Hydrologic Engineering, ASCE 2(4): 211-218.

St. Johns River Water Management District, 1997. Base.SJRWMD_LANDUSE_1995. Palatka, Florida.

United States Environmental Protection Agency, 1999. Protocol for Developing Nutrient TMDLs, First Edition.

United States Environmental Protection Agency, 2001. Protocol for Developing Pathogen TMDLs, First Edition.

11. Appendix A – FDEP TMDL for Lower St. Johns River

(Download as Separate PDF File)